UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 16, 2013

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3D-C
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 3, TRANSMITTAL OF FINAL ACCIDENT SEQUENCE PRECURSOR ANALYSIS

Dear Mr. Shea:

The enclosure provides the final results of the Accident Sequence Precursor (ASP) analysis of an event that occurred at Browns Ferry Nuclear Plant (BFN), Unit 3, as documented in Licensee Event Report 296/12-003 and Inspection Report 05000296/2012004.

The event occurred on May 22, 2012, at 2:49 a.m.; the BFN Unit 3 reactor was automatically scrammed due to de-energization of the reactor protection system from actuation of unit station service transformer 3A differential relay 387SA, which also resulted in a loss of 500 kilovolts (kV) power to BFN Unit 3. All BFN Unit 3 diesel generators successfully started and tied to their respective 4 kV shutdown boards. Power from the 161 kV offsite circuit remained available during the entire event. At 4:30 a.m., operators restored 500 kV power through the alternate feeder breakers to all BFN Unit 3's 4 kV shutdown boards.

All safety systems responded as expected and no emergency core cooling system water level initiation set points were reached. The reactor core isolation cooling system was manually started to control reactor water level. At the time of the reactor scram, the high-pressure coolant injection system was tagged out for removal of temporary instrumentation following planned maintenance.

The U.S. Nuclear Regulatory Commission (NRC) established the ASP Program in 1979 in response to the Risk Assessment Review Group Report (see NUREG/CR-0400, dated September 1978). The ASP Program systematically evaluates U.S. nuclear power plant operating experience to identify, document, and rank the operating events most likely to lead to inadequate core cooling and severe core damage (precursors). For more information about the ASP Program, see the NRC document "Accident Sequence Precursor (ASP) Program Summary Description," dated November 2008 (Agencywide Documents Access and Management System Accession No. ML13192A106).

The NRC Regulatory Issue Summary (RIS) 2006-24, "Revised Review and Transmittal Process for Accident Sequence Precursor Analyses" includes a revised process for the licensee review of the ASP analyses.

The ASP analysis calculated a final conditional core damage probability (CCDP) of 2×10^{-5} for Unit 3, which is less than the threshold for a significant precursor (i.e., CCDP greater than or equal to 1×10^{-3}). This event has a CCDP less than or equal to 1×10^{-4}; therefore in accordance with the RIS, a formal licensee review was not requested.

The complete summary of Fiscal Year 2012 ASP events that will include this event will be provided in the upcoming October 2013 Commission paper on the status of the ASP program and standardized plant analysis risk models.

The enclosure containing the final precursor analysis is provided for your information.

Sincerely,

Farideh E. Saba

Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-296

Enclosure:
Final Precursor Analysis

cc: Distribution via Listserv

Final Precursor Analysis

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research

Browns Ferry Nuclear Plant, Unit 3	Reactor Trip and Subsequent Loss of Offsite Power due Failure of Unit Station System Transformer Differential Relay	
Event Date: 05/22/2012	**LER:** 296/12-003-01 **IR:** 50-296/12-04	**CCDP** = 2×10^{-5}

EVENT SUMMARY

Event Description. On May 22, 2012, at 2:49 a.m., Brown Ferry Nuclear Plant, Unit 3, the reactor was automatically scrammed due to de-energization of the reactor protection system (RPS) from actuation of Unit Station Service Transformer (USST) 3A Differential Relay 387SA, which resulted in a loss of 500 kV power to Unit 3. This relay was picked up during a transfer of 4 kV Unit Board 3C from alternate power (161 kV) to normal power (USST 3A). All Unit 3 emergency diesel generators (EDGs) successfully started and tied to their respective 4 kV shutdown boards. Power from the 161 kV offsite circuit remained available during the entire event.

At 4:30 a.m., operators restored 500 kV power through the alternate feeder breakers to all Unit 3 4 kV unit boards. All safety systems responded as expected and no emergency core cooling system water level initiation set points were reached. The reactor core isolation cooling (RCIC) system was manually started to control reactor water level. Primary containment isolation system initiation signals for Groups 1–3, 6, and 8 were received as expected due to loss of offsite power. At the time of the reactor scram, the high pressure coolant injection (HPCI) system was tagged out for removal of temporary instrumentation following planned maintenance.

It was determined that the differential relay failure for USST 3A was installed with incorrect design calculation settings. This new differential relay was replaced during the last refueling outage that ended on May 20, 2012. Additional information is provided in References 1 and 2.

MODELING ASSUMPTIONS

Analysis Type. The Browns Ferry Unit 3 SPAR model, created in May 2012, was used for this event analysis. This event was modeled as a LOOP initiating event.

Analysis Rules. The ASP program uses Significance Determination Process results for degraded conditions when available. However, the ASP Program performs independent analysis for initiating events.

Key Modeling Assumptions. The following modeling assumptions were determined to be significant to the modeling of this event analysis:

- A reactor trip with a subsequent LOOP to both essential buses occurred.

- Offsite power was restored to Unit 3 shutdown boards one hour and 41 minutes after the LOOP occurred. However, offsite power from 161 kV source was available throughout the event; therefore, operators could have restored power to a Unit 3 shutdown boards earlier, if needed [i.e., during a postulated station blackout (SBO)]. See the section on Recovery Analysis for further details.

- The HPCI pump was considered inoperable at the onset of the LOOP because plant personnel were removing temporary instrumentation; however, the maintenance work instructions for the pump contained procedures to restore the pump if needed to provide a source of high-pressure makeup to the reactor. The analysis assumes that the pump could be recovered within 10–15 minutes.

Fault Tree Modification. The following fault tree modifications were necessary to perform this event analysis:

- A new basic event was added to the two HPCI fault trees: HCI and HCI-01. Basic event HCI-XHE-RECOVER (*Operators fail to recover HPCI Pump from Maintenance*) was added to account for potential recovery of the HPCI pump from maintenance. This new basic event along with basic event HCI-TDP-TM-TRAIN (*HPCI Train Is Unavailable Because Of Maintenance*) was moved and inserted under a new 'AND' gates (HCI-8 and HCI01-7, respectively). See Figures B-1 and B-2 in Appendix B for the modified HPCI fault trees.

Basic Event Probability Changes. The following initiating event frequencies and basic event probabilities were modified for this event analysis:

- This analysis models the May 22, 2012 reactor trip at Browns Ferry Nuclear Plant, Unit 3 as a switchyard-centered LOOP initiating event.
  - The probability of switchyard-centered LOOP (*IE-LOOPSC*) was set to 1.0; all other initiating event probabilities were set to zero.

- Basic Event HCI-TDP-TM-TRAIN (*HPCI Train is Unavailable Due to Test and Maintenance*) was set to 1.0 because the HPCI pump was out for maintenance.
  - The HPCI pump was determined to be recoverable within 10–15 minutes and procedures to return the pump to service were contained in the maintenance work instructions. The SPAR-H Human Reliability Analysis Method (References 4 and 5) was used to estimate this new human failure event (HFE). Tables 1 and 2 provide the key qualitative information for these recovery HFEs and the performance shaping factor (PSFs) adjustments required for the quantification for this recovery event using SPAR-H.

Table 1. Qualitative Evaluation for the Recovery of the HPCI Pump from Maintenance.

Definition	The definition for this recovery event is the operators failing to restore the HPCI pump to service from maintenance (to remove temporary instrumentation) to provide a source of high-pressure makeup to the to the reactor coolant system (RCS) given a LOOP and failure of RCIC.
Description and Event Context	HPCI availability is only a key concern during event mitigation if RCIC fails. If RCIC fails during a postulated SBO, only 30 minutes would be available to restore power to the shutdown board prior to core uncovery.

Operator Action Success Criteria	For successful recovery, operators must restore HPCI to operable status (i.e., able to perform its safety function) within 30 minutes of the loss of offsite power, postulated SBO, and subsequent failure of RCIC.
Nominal Cues	• Loss of offsite power occurs • RCIC fails
Procedural Guidance	Maintenance work instructions
Diagnosis/Action	This recovery contains sufficient diagnosis and action components.

Table 2. SPAR-H Evaluation of HEP for Recovery of the HPCI Pump from Maintenance.

PSF	Diagnosis / Action Multiplier	Notes
Time Available	1 / 1	The operators would need 10 to 15 minutes to perform the action component (i.e., to manipulate the valve, etc.) to align the HPCI pump to supply the RCS with high-pressure makeup. Therefore, the minimum time for diagnosis is approximately 15 minutes. Therefore, available time for the diagnosis component for 30 minute recovery is assigned as *Nominal Time* (i.e., ×1). Since sufficient time was available to for the action component of the recovery, the available time for the action component for the all recovery times is evaluated as *Nominal* (i.e., ×1). See Reference 5 for guidance on apportioning time between the diagnosis and action components of an HFE.
Stress	2 / 1	The PSF for diagnosis stress is assigned a value of *High Stress* (i.e., ×2) due to the LOOP, the failure of RCIC, and potential unavailability of RCS depressurization (due to operator error or hardware failure). The PSF for action stress was not determined to be a performance driver for these HFEs; and therefore, was assigned a value of *Nominal* (i.e., ×1).

PSF	Diagnosis / Action Multiplier	Notes
Complexity	2 / 1	The PSF for diagnosis complexity is assigned a value of *Moderately Complex* (i.e., ×2) because operators would have to deal with multiple equipment unavailabilities and the concurrent actions/multiple procedures during the LOOP, the failure of RCIC, and potential unavailability of RCS depressurization. The PSF for action complexity was not determined to be a performance driver for these HFEs; and therefore, was assigned a value of *Nominal* (i.e., ×1).
Procedures Experience/Training Ergonomics/HMI Fitness for Duty Work Processes	1 / 1	No event information is available to warrant a change in these PSFs (for diagnosis and action) from *Nominal* for these HFEs.

An HEP evaluated using SPAR-H is calculated using the following formula:

Calculated HEP = (Product of Diagnosis PSFs × 0.01) + (Product of Action PSFs × 0.001)
Therefore, the failure probability for HCI-XHE-RECOVER was set to 4×10^{-2}.

- Basic Event RCI-TDP-TM-TRAIN (RCIC *is Unavailable Because of Maintenance*) was set to FALSE because the RCIC pump will not be taken out of testing or maintenance while the HPCI pump is out for maintenance (would violate Technical Specifications).

- The offsite power was recovered to all of the Unit 3 shutdown boards in one hour and 41 minutes after the reactor trip and LOOP occurred; therefore, the default EDG and turbine-driven pump (RCIC and HPCI) mission times were changed to reflect the actual time offsite power was restored to the essential buses. Since the overall fail-to-run is made up of two separate factors, the mission times for these factors were set to the following: ZT-DGN-FR-E = 1 hour and ZT-TDP-FR-E = 1 hour (base case values) and ZT-DGN-FR-L = 0.75 hours and ZT-TDP-FR-L= 0.75 hours.

Offsite Power Recovery Analysis. The time required to restore offsite power to plant emergency equipment is a significant factor in modeling the CCDP given a LOOP. The LOOP/SBO modeling within the SPAR models include various sequence-specific power recovery factors that are based on the time available to recover offsite power to prevent core damage. Depending on the (1) availability of the turbine-driven, high-pressure injection systems (RCIC, HPCI); (2) the success or failure to depressurize the RCS; (3) the battery depletion time; the time available to restore offsite power prior to core damage during a postulated SBO for Browns Ferry, Unit 3 ranges from 30 minutes to 12 hours.

In this analysis, offsite power recovery probabilities are based on:

- Known information about when offsite power was available in the switchyard and when power was restored to the first shutdown board, and

- A determination on whether offsite power could have been restored sooner given a postulated SBO.
- Estimated probabilities of operators failing to realign offsite power to a shutdown board.

During the event, operators restored power to all of Unit 3 shutdown boards (from the 500 kV source) one hour and 41 minutes after the LOOP occurred. However, power from the 161 kV source was available for the entire duration of the event. To restore offsite power to one shutdown board, operators would need to determine that a LOOP occurred due to a loss of 500 kV offsite source. In addition, the operators would need to determine that offsite power was still available via the 161 kV source.

The SPAR-H Method was used to estimate non-recovery probabilities as a function of time following restoration of offsite power to the switchyard. Tables 3 and 4 provide the key qualitative information for these recovery HFEs and the PSFs adjustments required for the quantification of the HEPs using SPAR-H.

Table 3. Qualitative Evaluation of HFEs for Recovery of Offsite Power to a Unit 3 Shutdown Board.

Definition	The definition for these recovery HFEs is the operators failing to restore offsite power to a Unit 3 shutdown board via the 161 kV source within 30 minutes to 12 hours (depending on the sequence) given a postulated LOOP or SBO.
Description and Event Context	Depending on postulated failures of the recirculation pump seals (due to unavailability of seal injection/cooling), the availability of the high-pressure injection systems (HPCI, RCIC), and the time until the station batteries are depleted, operators would have between 30 minutes to 12 hours to restore power to a Unit 3 shutdown board via the unit boards powered by the 161 kV source.
Operator Action Success Criteria	For successful recovery, operators would have to align power from a unit board to a shutdown board prior to core uncovery. The time available for operators to perform this action would be a minimum of 30 minutes (given the failure of RCIC).
Nominal Cues	• Momentary de-energization of all plant AC electrical boards resulting in de-energization of running equipment • EDGs start and provide power to 4160 V and 480 V shutdown boards • Diesel Generator Start Failure annunciation • Reactor Scram and Main Turbine-Generator Trip • RPS MG Sets A and B trip resulting in all RPS trips sealed in • Primary and Secondary Containment Isolation
Procedural Guidance	0-AOI-57-1A, "Loss of Offsite Power (161 kV and 500 kV)/Station Blackout" 0-AOI-57-1B, "Loss of 500 kV" OI-82, "EDG Operations
Diagnosis/Action	These recovery HFEs contain sufficient diagnosis and action components.

Table 4. SPAR-H Evaluation of HEPs for Recovery of Offsite Power to a Unit 3 Shutdown Board.

PSF	Diagnosis / Action Multiplier	Notes
Time Available	1 or 0.01 / 1	The operators would need less than five minutes to perform the action component (i.e., to shut two breakers) to restore power to a shutdown board via the 161 kV offsite power source. Therefore, the minimum time for diagnosis is approximately 25 minutes. Therefore, available time for the diagnosis component for 30 minute recovery is assigned as *Nominal Time* (i.e., ×1). Available time for the diagnosis component for recoveries with at least one hour available are assigned as *Expansive Time* (i.e., ×0.01; time available is >2 times nominal and >30 minutes). Since sufficient time was available to for the action component of the recovery, the available time for the action component for the all recovery times is evaluated as *Nominal* (i.e., ×1). See Reference 5 for guidance on apportioning time between the diagnosis and action components of an HFE.
Stress	2 / 1	The PSF for diagnosis stress is assigned a value of *High Stress* (i.e., ×2) due to the postulated SBO. The PSF for action stress was not determined to be a performance driver for these HFEs; and therefore, was assigned a value of *Nominal* (i.e., ×1).
Complexity	2 / 1	The PSF for diagnosis complexity is assigned a value of *Moderately Complex* (i.e., ×2) because operators would have to deal with multiple equipment unavailabilities and the concurrent actions/multiple procedures during a postulated SBO. The PSF for action complexity was not determined to be a performance driver for these HFEs; and therefore, was assigned a value of *Nominal* (i.e., ×1).
Procedures Experience/Training Ergonomics/HMI Fitness for Duty Work Processes	1 / 1	No event information is available to warrant a change in these PSFs (for diagnosis and action) from *Nominal* for these HFEs.

Therefore, the failure probability for OEP-XHE-XL-NR30MHSC (*Operator Fails to Recover Offsite Power in 30 Minutes*) was set to 4×10^{-2}.

In addition, the failure probabilities for OEP-XHE-XL-NR01HSC (*Operator Fails to Recover Offsite Power in 1 Hour*), OEP-XHE-XL-NR04HSC (*Operator Fails to Recover Offsite Power in*

4 Hours), OEP-XHE-XL-NR10HSC (*Operator Fails to Recover Offsite Power in 10 Hours),* and OEP-XHE-XL-NR12HSC (*Operator Fails to Recover Offsite Power in 12 Hours)* were set to 1×10^{-3}.

ANALYSIS RESULTS

Conditional Core Damage Probabilities. The point estimate conditional core damage probability (CCDP) for this event is 2.0×10^{-5}.

The Accident Sequence Precursor Program acceptance threshold is a CCDP of 1×10^{-6} or the CCDP equivalent of an uncomplicated reactor trip with a non-recoverable loss of secondary plant systems (e.g., feed water and condensate), whichever is greater. This CCDP equivalent for Browns Ferry Unit 3 is 5×10^{-6}.

Dominant Sequence. The dominant accident sequence is LOOP/SBO Sequence 28-18 (CCDP = 1.4×10^{-5}) which contributes approximately 75% of the total internal events CCDP for Unit 1. The cutsets/sequences that contribute to the top 95% and/or at least 1% of the total internal events CCDP are provided in Appendix A.

The dominant sequence is shown graphically in Figures B-3 and B-4 in Appendix B. The events and important component failures in LOOP Sequence 28-18 are:

- LOOP occurs,
- Reactor scram succeeds,
- Emergency powers fails,
- Safety relief valves reclose (if opened),
- Recirculation pump seals integrity succeeds,
- RCIC succeeds,
- Operators fail to recover offsite power in 4 hours, and
- Operators fail to recover an EDG in 4 hours.

REFERENCES

1. Browns Ferry Nuclear Plant, Unit 3, "LER 296/12-003-01– Automatic Reactor Scram Due to De-Energization of Reactor Protection System from Actuation of 3A Unit Station Service Transformer Differential Relay," dated November, 26 2012. (ML12333A007)

2. U.S. Nuclear Regulatory Commission, "Browns Ferry Nuclear Plant - NRC Integrated Inspection Report 05000259/2012004, 05000260/2012004, and 05000296/2012004 and Notice of Enforcement Discretion," dated November 13, 2012. (ML12319A182)

3. Idaho National Laboratory, NUREG/CR-6883, "The SPAR-H Human Reliability Analysis Method," August 2005 (ML051950061).

4. Idaho National Laboratory, "INL/EXT-10-18533, SPAR-H Step-by-Step Guidance," May 2011 (ML112060305).

Appendix A: Analysis Results

Summary of Conditional Event Changes

Event	Description	Cond. Value	Nominal Value
HCI-XHE-RECOVERY	OPERATORS FAIL TO RECOVERY HPCI PUMP FROM MAINTENANCE	4.00E-2	N/A
HCI-TDP-TM-TRAIN	HPCI TRAIN IS UNAVAILABLE DUE TO TEST AND MAINTENANCE	TRUE	1.13E-2
IE-LOOPSC[a]	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)	1.00E+0	1.04E-2
OEP-XHE-XL-NR01HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR (SWITCHYARD)	1.00E-3	4.01E-1
OEP-XHE-XL-NR04HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS (SWITCHYARD)	1.00E-3	1.02E-1
OEP-XHE-XL-NR10HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 10 HOURS (SWITCHYARD)	1.00E-3	2.61E-2
OEP-XHE-XL-NR12HSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 12 HOURS (SWITCHYARD)	1.00E-3	1.90E-2
OEP-XHE-XL-NR30MSC	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 30 MINUTES (SWITCHYARD)	4.00E-2	6.02E-1
RCI-TDP-TM-TRAIN	RCIC PUMP TRAIN IS UNAVAILABLE BECAUSE OF MAINTENANCE	FALSE	1.09E-2
ZT-DGN-FR-L	DIESEL GENERATOR FAILS TO RUN	8.17E-4	1.09E-3
ZT-TDP-FR-L	TURBINE DRIVEN PUMP FAILS TO RUN	1.17E-3	3.52E-2

a. All other initiating event probabilities were set to zero.

Dominant Sequences (*Contribute ≥1% of the Total CCDP*)

Name	CCDP	Percentage	Sequence Path
LOOPSC: 28-18	1.44E-05	74.6%	/RPS, EPS, /SRV, /RPSL, /RCI01, OPR-04H, DGR-04H
LOOPSC: 28-34-3	1.44E-06	7.5%	/RPS, EPS, /SRV, RPSL, /RCI01, OPR-04H, DGR-04H
LOOPSC: 25	1.42E-06	7.4%	/RPS, /EPS, /SRV, HPI, DEP
LOOPSC: 04	5.36E-07	2.8%	/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, /CVS, LI01
LOOPSC: 06	5.31E-07	2.8%	/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, CVS, LI
LOOPSC: 24	3.29E-07	1.7%	/RPS, /EPS, /SRV, HPI, /DEP, LPI, VA
LOOPSC: 13	2.70E-07	1.4%	/RPS, /EPS, /SRV, /HPI, SPC, DEP
LOOPSC 28-30	2.22E-07	1.2%	/RPS, EPS, /SRV, /RPSL, RCI01, /HCI01, OPR-04H, DGR-04H
Total	**1.93E-05**		

Referenced Fault Trees

Fault Tree	Description
CVS	CONTAINMENT VENTING
DEP	MANUAL REACTOR DEPRESS
DGR-04H	DIESEL GENERATOR RECOVERY IN 4 HRS
EPS	TRANSFER BRANCH SBO
EXT	ACTIONS TO EXTEND ECCS OPERATION
HPI	HIGH-PRESSURE INJECTION (RCIC or HPCI)

Fault Tree	Description
LI	LATE INJECTION
LI01	BROWNS FERRY 3 LATE INJECTION FAULT TREE
LPI	LOW PRESSURE INJECTION (CS or LPCI)
OPR-04H	OFFSITE POWER RECOVERY IN 4 HRS
RCI01	REACTOR COOLANT INJECION
RHR	LOSS OF RESIDUAL HEAT REMOVAL SYSTEMS
RPSL	RECIRC PUMP SEAL INTEGRITY
SPC	SUPPRESSION POOL COOLING
VA	ALTERNATE LOW PRESS INJECTION

Important Cutsets (*from Dominant Sequences*)

#	CCDP	Total %	Cutset	Description
1	**9.79E-6**	**53.4**	**LOOPSC: 28-18**	**/RPS, EPS, /SRV, /RPSL, /RCI01, OPR-04H, DGR-04H**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	9.79E-6		ACP-CRB-CF-OPSD3	COMMON CAUSE FAILURE OF OFFSITE POWER FEED TO SHUTDOWN BOARDS
2	**4.57E-6**	**24.9**	**LOOPSC: 28-18**	**/RPS, EPS, /SRV, /RPSL, /RCI01, OPR-04H, DGR-04H**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	4.57E-6		RSW-STR-CF-ALL	RHRSW STRAINERS FAIL FROM COMMON CAUSE
3	**9.79E-7**	**5.34**	**LOOPSC: 28-34-3**	**/RPS, EPS, /SRV, RPSL, /RCI01, OPR-04H, DGR-04H**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	9.79E-6		ACP-CRB-CF-OPSD3	COMMON CAUSE FAILURE OF OFFSITE POWER FEED TO SHUTDOWN BOARDS
	1.00E-1		RRS-MDP-LK-SEALS	RECIRCULATION PUMP SEALS FAIL
4	**5.00E-7**	**2.73**	**LOOPSC: 04**	**/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, /CVS, LI01**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	1.00E-3		OPR-XHE-XM-LI01	OPERATOR FAILS TO START/CONTROL LATE INJECTION
	5.00E-4		RHR-XHE-XM-ERROR	OPERATOR FAILS TO START/CONTROL RHR
5	**5.00E-7**	**2.73**	**LOOPSC: 06**	**/RPS, /EPS, /SRV, /HPI, SPC, /DEP, /LPI, RHR, CVS, LI**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	1.00E-3		CVS-XHE-XM-VENT	OPERATOR FAILS TO VENT CONTAINMENT
	5.00E-4		RHR-XHE-XM-ERROR	OPERATOR FAILS TO START/CONTROL RHR
6	**4.57E-7**	**2.49**	**LOOPSC: 28-34-3**	**/RPS, EPS, /SRV, RPSL, /RCI01, OPR-04H, DGR-04H**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	1.00E-1		RRS-MDP-LK-SEALS	RECIRCULATION PUMP SEALS FAIL
	4.57E-6		RSW-STR-CF-ALL	RHRSW STRAINERS FAIL FROM COMMON CAUSE

#	CCDP	Total %	Cutset	Description
7	**3.80E-7**	**2.07**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	4.00E-2		HCI-XHE-RECOVERY	OPERATORS FAIL TO RECVOVER HPCI PUMP FROM MAINTENANCE
	1.90E-2		RCI-XHE-XE-MISCAL	RCIC FAILS FROM MISCALIBRATION OF RUPTURE DISC
8	**2.50E-7**	**1.36**	**LOOPSC: 13**	**/RPS, /EPS, /SRV, /HPI, SPC, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	5.00E-4		RHR-XHE-XM-ERROR	OPERATOR FAILS TO START/CONTROL RHR
9	**1.71E-7**	**0.93**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	1.50E-1		HCI-MOV-CC-IVFRO	HPCI INJECTION VALVE FAILS TO REOPEN
	1.50E-1		HCI-MULTIPLE-INJECT	MULTIPLE HPCI INJECTIONS REQUIRED
	8.00E-1		HCI-XHE-XL-INJECT	OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN
	1.90E-2		RCI-XHE-XE-MISCAL	RCIC FAILS FROM MISCALIBRATION OF RUPTURE DISC
10	**1.30E-7**	**0.71**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	4.00E-2		HCI-XHE-RECOVERY	OPERATORS FAIL TO RECVOVER HPCI PUMP FROM MAINTENANCE
	6.49E-3		RCI-TDP-FS-TRAIN	RCIC PUMP FAILS TO START
11	**1.12E-7**	**0.61**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	4.00E-2		HCI-XHE-RECOVERY	OPERATORS FAIL TO RECVOVER HPCI PUMP FROM MAINTENANCE
	5.59E-3		RCI-TDP-FR-TRAIN	RCIC PUMP FAILS TO RUN GIVEN THAT IT STARTED
12	**6.36E-8**	**0.35**	**LOOPSC: 28-30**	**/RPS, EPS, /SRV, /RPSL, RCI01, /HCI01, OPR-04H, DGR-04H**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	9.79E-6		ACP-CRB-CF-OPSD3	COMMON CAUSE FAILURE OF OFFSITE POWER FEED TO SHUTDOWN BOARDS
	6.49E-3		RCI-TDP-FS-TRAIN	RCIC PUMP FAILS TO START
13	**6.17E-8**	**0.34**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	6.49E-3		HCI-TDP-FS-TRAIN	HPCI PUMP FAILS TO START
	1.90E-2		RCI-XHE-XE-MISCAL	RCIC FAILS FROM MISCALIBRATION OF RUPTURE DISC

#	CCDP	Total %	Cutset	Description
14	**6.00E-8**	**0.33**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	4.00E-2		HCI-XHE-RECOVERY	OPERATORS FAIL TO RECVOVER HPCI PUMP FROM MAINTENANCE
	1.50E-1		RCI-RESTART	RESTART OF RCIC IS REQUIRED
	8.00E-2		RCI-TDP-FS-RSTRT	RCIC FAILS TO RESTART GIVEN START AND SHORT-TERM RUN
	2.50E-1		RCI-XHE-XL-RSTRT	OPERATOR FAILS TO RECOVER RCIC FAILURE TO RESTART
15	**5.84E-8**	**0.32**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	1.50E-1		HCI-MOV-CC-IVFRO	HPCI INJECTION VALVE FAILS TO REOPEN
	1.50E-1		HCI-MULTIPLE-INJECT	MULTIPLE HPCI INJECTIONS REQUIRED
	8.00E-1		HCI-XHE-XL-INJECT	OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN
	6.49E-3		RCI-TDP-FS-TRAIN	RCIC PUMP FAILS TO START
16	**5.47E-8**	**0.3**	**LOOPSC: 28-30**	**/RPS, EPS, /SRV, /RPSL, RCI01, /HCI01, OPR-04H, DGR-04H**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	9.79E-6		ACP-CRB-CF-OPSD3	COMMON CAUSE FAILURE OF OFFSITE POWER FEED TO SHUTDOWN BOARDS
	5.59E-3		RCI-TDP-FR-TRAIN	RCIC PUMP FAILS TO RUN GIVEN THAT IT STARTED
17	**5.31E-8**	**0.29**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	5.59E-3		HCI-TDP-FR-TRAIN	HPCI PUMP TRAIN FAILS TO RUN GIVEN IT STARTED
	1.90E-2		RCI-XHE-XE-MISCAL	RCIC FAILS FROM MISCALIBRATION OF RUPTURE DISC
18	**5.03E-8**	**0.27**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	1.50E-1		HCI-MOV-CC-IVFRO	HPCI INJECTION VALVE FAILS TO REOPEN
	1.50E-1		HCI-MULTIPLE-INJECT	MULTIPLE HPCI INJECTIONS REQUIRED
	8.00E-1		HCI-XHE-XL-INJECT	OPERATOR FAILS TO RECOVER HPCI INJECT MOV FAILURE TO REOPEN
	5.59E-3		RCI-TDP-FR-TRAIN	RCIC PUMP FAILS TO RUN GIVEN THAT IT STARTED

#	CCDP	Total %	Cutset	Description
19	**3.98E-8**	**0.22**	**LOOPSC: 25**	**/RPS, /EPS, /SRV, HPI, DEP**
	1.00E+0		IE-LOOPSC	LOSS OF OFFSITE POWER INITIATOR (SWITCHYARD-CENTERED)
	5.00E-4		ADS-XHE-XM-MDEPR	OPERATOR FAILS TO DEPRESSURIZE THE REACTOR
	4.00E-2		HCI-XHE-RECOVERY	OPERATORS FAIL TO RECVOVER HPCI PUMP FROM MAINTENANCE
	7.97E-3		RCI-MOV-FC-XFER	RCIC FAILS TO TRANSFER DURING RECIRCULATION
	2.50E-1		RCI-XHE-XL-XFER	OPERATOR FAILS TO RECOVER SUCTION TRANSFER FAILURE

Appendix B: Modified Fault Trees and Key Event Trees

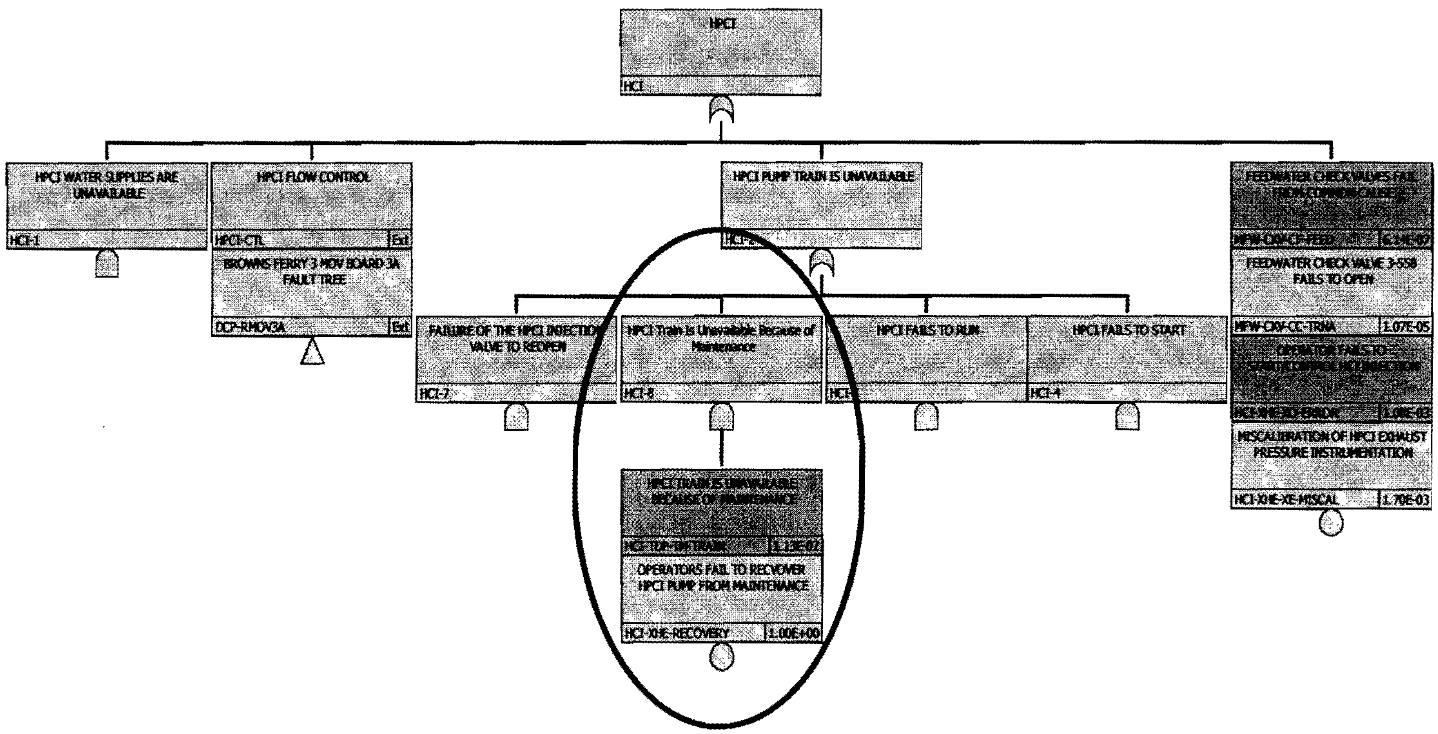

Figure B-1. Modified HPCI fault tree (*HCI*).

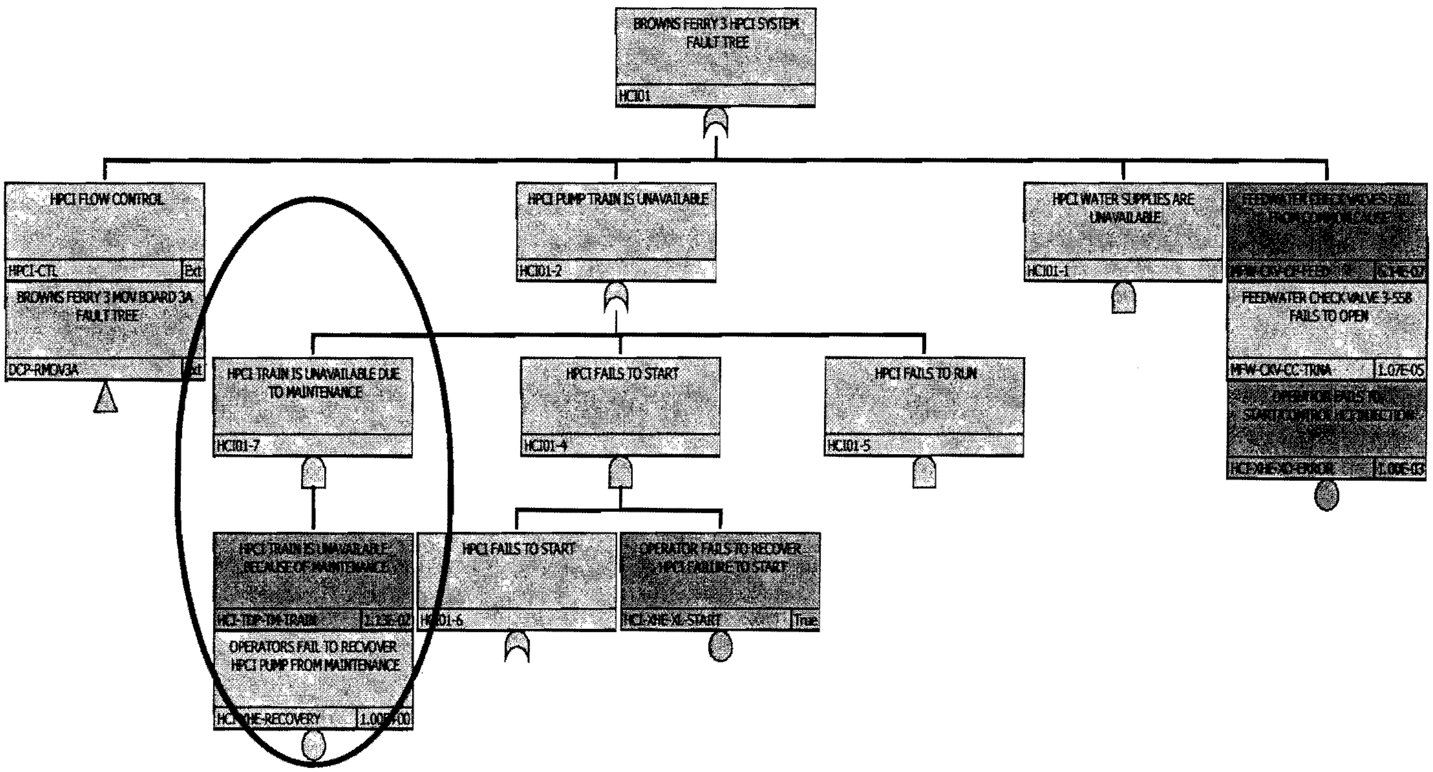

Figure B-2. Modified HPCI fault tree (*HCI01*).

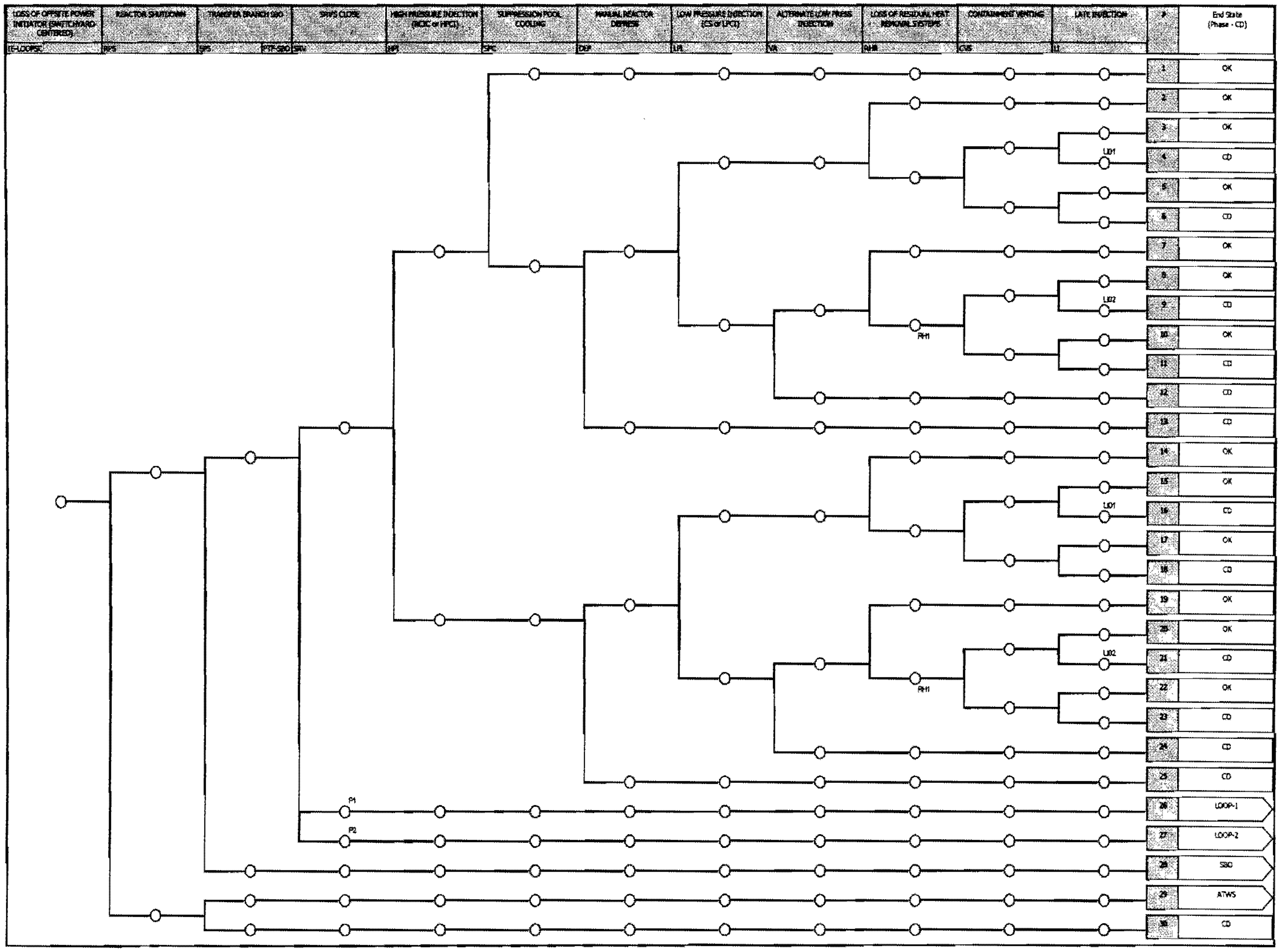

Figure B-3. Browns Ferry Nuclear Plant, Unit 3 LOOP event tree.

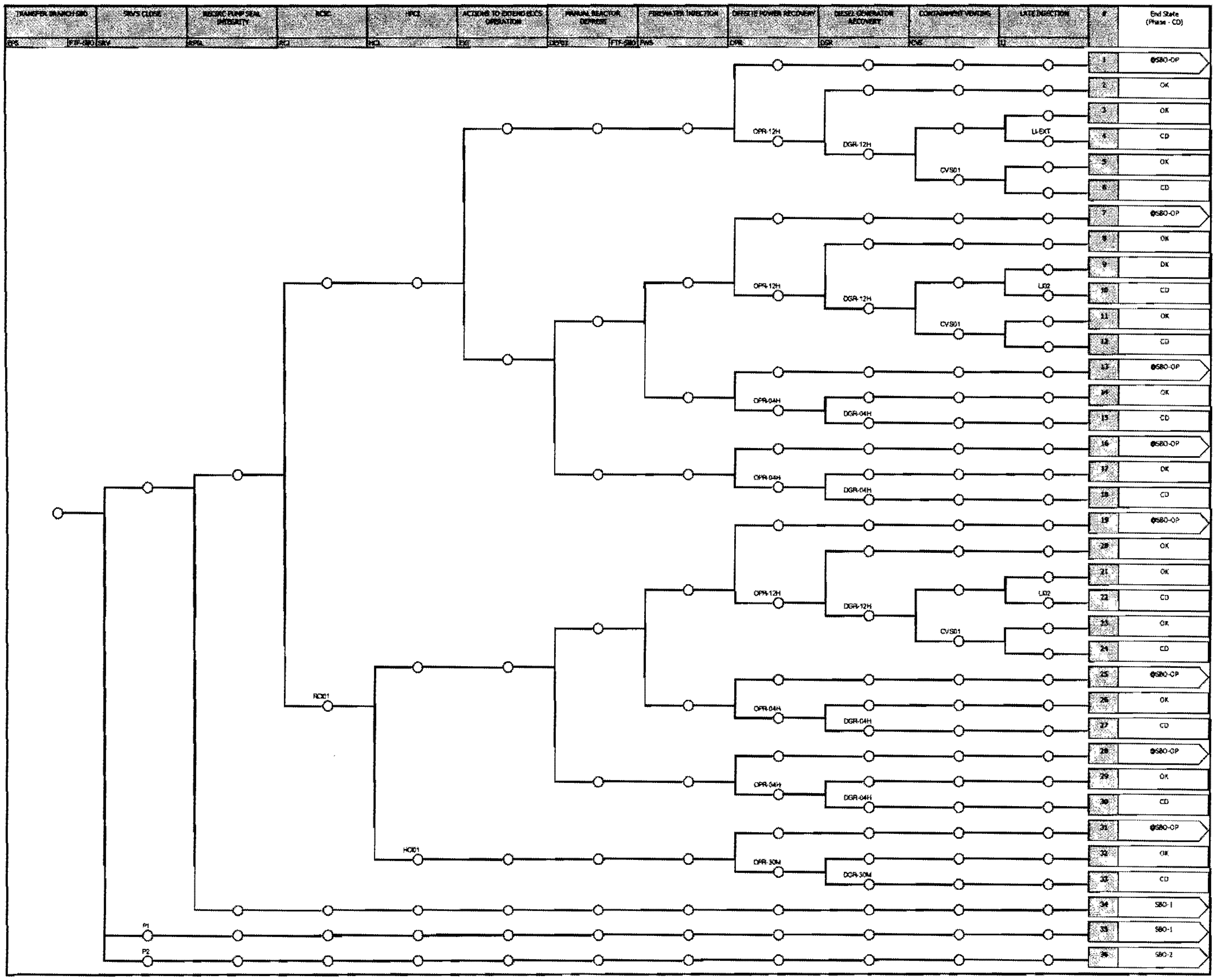

Figure B-4. Browns Ferry Nuclear Plant, Unit 3 SBO event tree.

The ASP analysis calculated a final conditional core damage probability (CCDP) of 2×10^{-5} for Unit 3, which is less than the threshold for a significant precursor (i.e., CCDP greater than or equal to 1×10^{-3}). This event has a CCDP less than or equal to 1×10^{-4}; therefore in accordance with the RIS, a formal licensee review was not requested.

The complete summary of Fiscal Year 2012 ASP events that will include this event will be provided in the upcoming October 2013 Commission paper on the status of the ASP program and standardized plant analysis risk models.

The enclosure containing the final precursor analysis is provided for your information.

Sincerely,

/RA/

Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-296

Enclosure:
Final Precursor Analysis

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